THE DIAGNOSIS OF OBSCURE CASES OF RENAL AND URETERAL CALCULUS.

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The importance to the patient and to the surgeon of an accurate diagnosis as to the presence or absence of calculus in the kidney, or ureter, and of the exact location of the calculus when its removal is contemplated, entitles this subject to attention.

Calculus in the kidney, in a calix or a dilated pelvis, may be exceedingly difficult to find at operation, with the kidney delivered and in full view. In such a case, it is impossible often to palpate a stone of the size of a black bean (½ inch by ¼ inch by ¼ inch) through the lips of the hilum, and such a calculus may easily be displaced upward or downward into a calix so that palpation through the kidney substance, or by means of a finger inserted into an opening in the pelvis (which finger-tip cannot be made to enter the calix), may fail to discover it, and splitting the kidney from end to end opening into all calices may, in extreme cases, be necessary. Needling, probing, etc., may also fail.

Calculus in the abdominal ureter, and at the lower extremity of the ureter when in the intramural portion, is quite accessible for removal, while one situated one or two inches above the bladder wall in the pelvic ureter involves an operation for its removal which is classed among the most difficult of surgical procedures. Even a Kraske mutilation has been proposed for access to this part of the ureter.

If the calculus is not found in the kidney, but an obstruction is found by a ureteral probe passed down from the pelvis, a prolongation of the operation through a second incision for access to this part, or a deferred second operation, is necessary.

To safeguard the patient from unnecessarily mutilating operations and to avoid long and, as has all too frequently been the case, even fruitless search, a definite conclusion as to the site of the calculus should be painstakingly sought before operation is advised.

In many cases it is by no means simple to differentiate infected calculus disease from other diseases of the kidney and its pelvis, such as pyelitis, pyelonephritis, pyonephrosis and tuberculosis, or from vesical tuberculosis and prostatitis, and the cases without pyuria from renal neoplasm and some forms of nephritis or from diseases of neighboring organs, such as cholecystitis, cholelithiasis, pancreatitis, pancreatic calculus, gastric disease, intestinal colics, appendicitis, ovarian and tubal disease.

Typical cases of nephrolithiasis may present features from which a diagnosis is speedily reached, but not infrequently all the means at command must be brought to bear to definitely conclude upon the cause of the symptoms and the site of the calculus.

A calculus in the lower ureter may, and not infrequently, does give rise to subjective symptoms, precisely the same as those caused by a calculus high in the upper pole of the kidney. This fact is frequently overlooked by surgeons who depend upon the history, physical signs and radiographs of the kidney only, and, finding no shadow after a satisfactory series of plates, conclude that nephrolithiasis can be excluded.

Lumbago, sciatica, chronic appendicitis, peritoneal adhesions, chronic cholecystitis, tubal and ovarian disease are explanations given to patients to help them bear the pains of renal and ureteral calculi because of incomplete examination. Within the past year the writer has seen patients upon each of whom one of these diagnoses has been made, each of whom has borne his suffering for years—some of them have undergone operation—after which recurrence of the familiar pain has been ascribed to another of the list, usually to the common peritoneal adhesion.

It is the duty of the urinary surgeon to make clear the diagnosis in these cases. This is possible in practically every case. Yet, with all our means of determining a diagnosis, there are cases which are baffling. An outline of procedure is as follows: 1. History; 2. Examination of urine; 3. Physical examination; 4. X-ray examination; 5. Special instrumentation.

History.—The main subjective symptoms of cases of suspected nephrolithiasis may be classed, for brevity, under two heads: (1) Pain, and (2) Changes in urination, *i.e.*, disturbance of function and alteration in the character of the urine. Pain may be entirely absent or there may have been, in the past, a scarcely remembered discomfort which lasted but a short time, and these cases lead their advisers to conclude often that, without renal colic, no renal calculus can exist. No one symptom is so deceptive in this condition as the description of pain which patients give. Pain in the spine, weakness of the back, aching in the ilium, lumbago, sciatica, are commonly described, by one as mild, by another as agonizing. The severity and character of pain have doubtless, in great part, a direct relation to the traumatism done by the movement of the calculus or the distention of the pelvis and ureter above a partial or complete obstruction, and the back pressure produced thereby upon the kidney, which secretes under difficulty and, we may reasonably presume, becomes hyperæmic or congested, with consequent distention of its capsule. A cramp contraction (tonic spasm) of the muscular coat of the pelvis and ureter, combined with traumatism to the mucous membrane, accounts for ureteral colic. This pain is often reflexly felt along the distribution of the ilio-inguinal, genito-crural, and sciatic nerves. The character of the calculus has much to do with the severity of the pain and the traumatism produced. A sharp or rough calculus (as many calcium oxalate and phosphatic calculi) the size of a pin-head, may produce the most agonizing colic, while a smooth surfaced stone, nearly as large as a cherry, may be borne in the pelvis, or ureter, without severe pain throughout life. Either of these may give rise to any of the pathological conditions consequent upon partial urinary obstruction, such as dilation above it with infection sooner or later, as usually occurs wherever a stasis of urine is found.

Calculus in the kidney, in a calix, or in the pelvis, produces pain which is referred to the kidney region and all along the ureter, which shares in the spasm set up by efforts to expel it from above.

The site of pain (not colic) may be said to be either at the point of obstruction by the calculus or above it, commonly, of course, at the site of the calculus; but, in some cases, this point is neither referred to as the most painful area, nor is there great tenderness on palpation of a calculus. The greatest pain is often referred to the region of the kidney, or along the ureter above the situation of the calculus when it is in the ureter.

Changes in urination consist in disturbances of this functon and alterations in the character of the urine. The functional disturbances are painful, frequent, or irregular, imperative demands for urination, or there may be infrequent urination—oliguria; anuria.

Either typical renal calculus pain, or change in urination, and in the character of the urine, may be absent from the history. These cases, in which the two cardinal symptoms are not combined, form a large class, and are frequently told that renal calculus can be excluded. Those who have right-sided pain, without urinary symptoms, are not uncommonly subjected to appendectomy and exploratory laparotomy for examination of the gall-bladder and bile ducts, or to search for the wary peritoneal adhesions or, in the female, undergo pelvic operations for purposes of investigation.

Those who complain of disturbance of urination, or show gross changes in the urine, are more fortunate in having attention immediately called to the urinary tract.

The importance of the careful examination of centrifugated urine, when the suspicion of renal calculus has been aroused, has been repeatedly emphasized. The failure to carry out completely this part of the examination accounts for many failures in diagnosis. It is, however, common observation that a renal colic, due to calculus, is accompanied by, and subsequently shows, no trace of red blood cells in carefully examined specimens. This is explainable when a smooth surfaced calculus causes no trauma upon the mucous membrane and the muscular spasm of the pelvis and ureter has not produced such squeezing of the mucous membrane that rupture, or diapedesis, results.

Calculus situated above the lower pelvic ureter may never give rise to frequent or painful urination, while calculus in that portion near the bladder, especially when in the intramural portion, almost invariably sets up spasmodic contractions of the viscus, such as are caused by prostatic or urethral disease. Renal and ureteral colic may communicate the muscular spasm to the bladder, and calculus disease seems, at times, to cause vesical irritability without recognizable changes in the bladder or in the chemical or microscopic character of the urine.

In purulent urine, of whatever origin, red blood cells are commonly encountered, but are often difficult to distinguish in the fields of pus under the microscope, so that, in the infected cases, a minute quantity of blood is an ambiguous sign. In aseptic cases, however, great significance can be attributed to a few red blood cells found in voluntarily passed urine. The use of a soft rubber catheter may, in the most skillful hands, cause sufficient trauma to the delicate mucous membrane about the sphincter, along the posterior urethra, or upon the floor of the bladder, to show red blood cells in a specimen drawn in this way—consequently, we must place most reliance in the finding of hæmaturia upon specimens passed voluntarily under precautions of cleanliness. In women, this may require a special technique.

There are some who assert that, in many cases, the character (size and shape) of epithelial cells, found in urine, give a definite clue as to the site of a lesion, situation of a calculus, etc. This is doubtless true in cases where a marked preponderance of one type of cells is found, but the opinion of many competent clinical pathologists seems to be that this is rarely the case in surgical urinary affections. Certain types of crystals are said also to preponderate with calculus of uric acid, calcium oxalate, or phosphate, respectively. In looking over some of the reports of others, and of our own, we find that the crystals found in urine often do not at all correspond in nature with that of a calculus present. Phosphatic deposits are as often found in urine where a uric acid calculus exists, as urate or uric acid deposits; and uric acid, urates and oxalates are found in cases which carry phosphatic calculus, so that we are led to question a diagnosis of the variety of calculus based upon the variety of crystals appearing in the urine.

Physical Examination.—Physical examination, as ordinarily meant by inspection, palpation and percussion, gives ample resource for the investigation of the cause and seat of disease, and should be carried out with careful record of the signs which it gives. Yet the history, urine examination, and physical examination, efficiently made, do not afford conclusive evidence of the presence of a calculus and its location.

Localized tenderness is usually elicited when pressure is exerted upon the site of a calculus. A localized point of tenderness will often mislead if it is not clearly recognized that there may be no especial tenderness at the site of the calculus but great pain on palpation over the distended or diseased portion of the tract above the obstruction. When a calculus projects from a ureter mouth into the bladder, it may be palpated by rectum or vagina, touched by a sound or searcher, transmitting the characteristic sensation to the finger and heard by the ear, and also it is plainly visible by the cystoscope.

It is certainly a rare experience for a surgeon to palpate a calculus, or several calculi, in the kidney. Calculus in the abdominal ureter is rarely found on palpation. In very thin, or lax-walled bodies, this is possible at times. Calculus, in the pelvic ureter, is palpable by rectum, in the male, only when lying immediately above or in the intramural portion of the ureter. Between the crossing of the iliac vessels and the vesical juncture, there is an extent of ureter of approximately 10 cm.—nearly four inches—which in the male, and in most females, is out of reach of the palpating finger.

X-Ray Examination.—By this means a positive diagnosis of calculus in the kidney, renal pelvis, or ureter, can be made, for the reason that this, when positive, is a physical demonstration as certain as direct eyesight.

The Röntgen-ray has proved to be of inestimable value as a diagnostic aid, especially for lesions of bones and for the discovery of urinary calculi. It is essential for complete examination when urinary calculus is suspected. Without it, no combination of other signs is convincing—yet it has limitations. Hardly more demand must be made upon this form of clinical research than is made upon others which are older and whose value and limitations are now recognized by all.

No reasonable physician expects a positive exclusion of tuberculosis because tubercle bacilli are not found in sputum or urine, when signs give weight to this suspicion. So we cannot positively state that calculus does not exist in the urinary tract after several satisfactory plates are obtained of each part of the tract. I believe, after some experience in radiography, that a positive statement that calculus can be excluded, by reason of any X-ray examination, is unwarranted. Fortunately, it is only rarely that the pure uric acid, or urate calculus, exists. I recently saw a large calculus in a bladder by means of the cystoscope, and was astonished to obtain clear plates of the pelvis, showing no shadow which might, of itself, arouse the suspicion of calculus. In order not to judge my own X-ray results as conclusive, this patient was sent to Dr. E. W. Caldwell, and his plates, he frankly stated, would not have led him to make the statement that calculus existed, had he not known of its presence. A very short exposure, with a very low tube, brought out a shadow, which we could recognize as that of the calculus, after its removal by cystotomy. This point is of such importance that a description of this large vesical calculus is given. It is a bi-convex disc, reddish brown in color—measuring 51 by 46 by 22 mm., weighing 42.2 grams—composed of uric acid in its periphery, and uric acid and sodium urate in its center. This, and other experiences, lead me to believe that some cases harbor calculus which have been positively stated to be calculus free.

Some experiments with calculi which had been carefully analyzed, as well as with the pure powders of the various constituents of calculi, give me reason to doubt the possibility of obtaining shadows of calculi composed of uric acid or urates, without admixture of other salts. A uric acid calculus, having a very slight admixture of oxalate, phosphate, or carbonate, or a very thin coating of any of these salts, can be demonstrated clearly.

The plates, which failed to reveal a recognizable shadow of the large calculus mentioned, show the coccyx quite distinctly to its tip, and this calculus covered this bone at the time.

Pure uric acid, sodium urate, and ammonium urate, absorb very little of the X-ray and give a barely recognizable shadow even when placed directly upon the plate. Most uric acid, and urate calculi, have some oxalate salt in or upon them—often a bare trace only upon analysis—yet this is sufficient to give them resistance to, or absorption of X-rays and a definite shadow upon a plate.

The X-ray examination, however, in the great majority of cases, is competent to show accurately the size, shape and location of a calculus in any part of the urinary tract in practically every individual, without regard to size, adipose or muscular development. In favorable subjects, we should get the shadow of the kidney and be able to determine very accurately the position of a calculus in it, *i.e.*, whether the calculus lies in the pelvis, in an upper or lower calix, or far out in the renal parenchyma. The importance of this accuracy is appreciated when the number of cases in which the search by palpation, needling, probing, and splitting, is carried on, and even abandoned without removal of the object sought.

If the surgical work can be limited to a small part of the kidney, or to the pelvis, without resort to examination first of parts where we can be sure the calculus does not lie, an advantage is gained.

I have recently seen patients who have been subjected to operation during which the calculus was not found after prolonged search, whose symptoms have naturally persisted and in whom the calculus could still be clearly demonstrated upon radiographs.

The deceptive shadows, such as those of phleboliths, calcareous deposits in muscles or tendons, calcareous appendices-epiploicæ or dense material found in the intestine frequently, can be excluded positively. Dr. G. E. Brewer's case of calcareous appendix-epiploica, adherent to the wall of the ureter, is in a class by itself and must exist very rarely.

Several (two or more) plates, taken at different times and at different angles, should always be made before a statement as to the situation of and nature of a body casting a shadow upon an X-ray plate, is made.

This does not involve risk to the patient, so far as deleterious effects from X-rays are concerned, if exposures are short —not over two minutes in all—for several plates, and should involve shorter exposure-time wherever practicable. Satisfactory X-ray plates can only be obtained when the intestinal tract is practically empty. We should get a shadow of the kidney itself—the normal kidney even—and, in plates of the pelvis, should show the coccyx to its tip as well as obtaining the detail of thick muscle and bone extremities demanded by judges of X-ray plates in order to consider this examination satisfactory.

The cause of the impossibility, as I believe, even in small and thin subjects, of showing the presence of the pure uric acid, or urate calculi, by means of X-ray and because of the uncertainty of any combination of symptoms, and in many cases also the baffling evidence, or lack of evidence, elicited by the physical signs, we must resort to special methods for aids in determining the diagnosis.

Special Instrumentation.—The data obtained by a cystoscopic examination of the bladder often give very strong evidence of the presence of calculus in the ureter. When hæmorrhage, or pyuria, occurs in these cases, we usually have pain as a symptom to guide us to the suspected side and may see the dark or cloudy jet from that ureter mouth.

A calculus projecting through the ureter mouth may be easily seen. A calculus, just within the ureter mouth, gives a marked tumefaction of the mucous membrane all about the mouth of the ureter. A calculus still higher in the ureter, *i.e.*, above the intramural portion, may produce no change visible at the mouth and yet it may be the cause of a hyperæmia or œdema, or protrusion (prolapse) of the mucous membrane, with or without petechial points, because of the frequently repeated physiologic efforts to expel the foreign substance.

Not too much reliance can be placed upon "ureteric meatoscopy" for real evidence as to the condition above the mouth of the ureter. The appearance of the ureteric meatus gives grounds for valuable suspicions—rarely is it evidence.

The catherization of both ureters at the same time, for the collection of a sufficient quantity (10–30 c.c.) of the excretion of each kidney for comparative chemical, microscopical, bacteriological (including cultures) and physical examinations, gives most important data, aiding in determining the pathologic condition of the affected tract and the condition of the other and in pointing to the surgical procedure to follow.

A kidney, irritated by a concretion, seems to be stimulated to great activity (unilateral polyuria)—an effort no doubt to expel the offender when there is an open course through the ureter. Its functional activity also seems to be impaired, for the amount of solids excreted in the urine from such a kidney usually compares unfavorably with that of its fellow.

Abnormal constituents, or a relatively abnormal amount of epithelium, from the pelvis and from the tubules (catarrhal pyelitis) may be obtained from the affected ureter and, while hæmorrhage is occurring or if infection has already occurred, blood and pus will demonstrate these conditions.

When nephrectomy is contemplated, the importance of knowing that the other kidney exists and is functionally competent is obvious. To "take the chance" that it is present and vigorous, and then have the autopsy reveal its absence or pathologic condition is not good surgery.

The necessary time, trouble and discomfort devoted to cystoscopic and ureter examination before operation are amply compensated for when, during a proposed nephrotomy, uncontrollable hæmorrhage or an unsuspected condition of the kidney make the removal of the entire organ necessary.

After some experience with the cryoscopy test, I have been led to the conclusion that the determination of the freezing points of the separate renal products gives us no more reliable knowledge of the comparative capabilities of the kidneys than is brought out by the complete chemical and microscopic examinations, which should never be omitted.

Ureter-Catheter as a Probe.—The ureter-catheter may give strong indications of the presence of a calculus by coming in contact with it in the ureter and being obstructed in its advance upward. This, too, is frequently a pitfall because of the readiness of the catheter to become caught in a fold of mucous membrane, or to fail to follow the course of its lumen because of its stiffness, or too great flexibility. The catheter is at times obstructed by a stricture, which may have no relation to the site of the present calculus. A ureter, harboring a calculus, will very often permit of stretching without pain so that the catheter is easily passed beyond it. This has been done in numerous cases in which calculus has been demonstrated.

It is justifiable to conclude that complete obstruction exists when no jet of urine is seen to issue from the mouth of the ureter during a comparatively long observation, even after hypodermatic injection of indigo-carmine, and when catheters of large and very small calibre refuse to pass beyond the same point and no fluid escapes through any catheter.

Kelly's method of smoothly coating the tip of a catheter with wax and passing it up to or beyond the calculus, so that scratch marks are made into the wax by the hard, rough calculus, is advantageous in many cases, in women especially, with his own method of ureter-catherization, but it is liable to lead to erroneous conclusions when used in the direct-illumination cystoscopes of European or American design, by reason of impressions upon the wax made by the catheter canals in these instruments. By means of the wax-tipped catheter, in suitable cases and in experienced hands, one of the best evidences of the site of calcareous material in a ureter may be obtained.

The phonendophore (metal-tipped auscultatory ureteral bougie), as devised by several men, has been used by me. It is a promising means of searching a ureter and renal pelvis.

A ureter-catheter, bearing a stylette of metal, preferably soft wire of small size, may be passed through the length of the ureter and, as first done by Dr. F. Tilden Brown in 1898, a radiograph immediately taken to show the course of the ureter. A shadow coinciding with this line is, in most instances, a ureteral calculus; yet here error may be made, for this simply represents shadows falling in the antero-posterior plane of the stylette, and any shadow-casting body lying in that plane, from the skin of the abdomen to the skin of the back, may be mistaken for a calculus in the ureter in contact with that stylette. This error can be almost certainly avoided if stereoscopic radiographs are taken of the styletted catheter in the ureter.

When the calculus obstructs the passage of the catheter through the ureter, or lies in the renal pelvis, the radiograph should show the shadow of the stylette extending up to the obstruction, giving by measurement its distance from the ureter mouth and, by its relations to the body structures shown in the radiograph, an accurate estimate of the point to be attacked surgically.

The distention of the renal pelvis, through a ureter-catheter by injecting fluid until pain is produced, for the purpose of determining whether the subjective sensation of the patient is the same as, or a different experience from that of the attacks from which relief is sought, is not commonly employed, but, at times, has given important additional evidence in doubtful cases. It is occasionally valuable for evidence in making a differential diagnosis from extra-urinary pain.

These details of methods, with some of the weaknesses of each, would seem to make the diagnosis of obscure cases of renal and ureteral calculi not only difficult, but tedious and complicated, and (some will say) in the end leading to no more definite conclusions, so that exploratory operation will be the outcome after all. This may doubtless be true in a very few cases. The condition in the urinary tract, which fails to be revealed by such an examination, must be rare indeed. And so, in these same cases, exploratory operation will as frequently fail to remove and fail even to reveal the cause. The frequency of exploratory operations in this country appears to me a blot upon American surgery. The usual physical examination, cystoscopy, collection of sufficient quantity of secretion from each kidney, examining the lumen of the ureter, and radiograph, while a styletted catheter lies in the ureter, can all be accomplished at one visit within the space of one hour, with the proper preparation of the patient and the necessary facilities at hand. It is preferable, however, to divide the examination into two or more parts, making the physical examination and cystoscopy at one time, with the ureter and X-ray tests subsequently.

The baffling cases in which a diagnosis cannot be made—so far as our present methods go—are those in which a smooth pure uric acid, or urate calculus, exists without obstructing the flow of urine and without infection. These patients have pain, and we suspect the urinary tract, or they have painless hæmaturia, yet we cannot demonstrate positively the presence, or absence, of calculus. It is, we believe, a rare condition.

I take this opportunity of expressing gratefully my indebtedness to Dr. F. Tilden Brown, with whom I am associated, for opportunities to see many of his cases and for the use of his records in the study of this subject.